

# **HEP Programs at BNL and the FY 2004 Budget**

**Presented to  
HEPAP**

**by  
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# Elements of the BNL HEP Program

The following elements comprise the current HEP Program\*:

- **Performance of a world class, in-house program of basic research in theoretical and experimental particle physics**
  - theory group of broad capability with productive links to nuclear physics
  - experimental groups in forefront efforts at BNL, CERN and Fermilab
- **Construction and operation of forefront user facilities for HEP experiments**
  - AGS Complex (highest intensity proton synchrotron in the world) shutdown!
  - accelerator and detector subsystems for use at Fermilab and CERN
  - Tier-1 computing center for support of the US ATLAS HEP program
- **Performance of a leading R&D effort in the development of advanced accelerator and particle detector concepts plus provision of computing support for HEP**
  - operation of ATF user facility for development of novel accelerator concepts
  - muon collider/storage ring conceptual design and enabling experiments
  - development (with Instrumentation Division) of novel particle detectors
  - R&D for superconducting magnet concepts applicable to HEP uses

\*Many of these areas of expertise provide benefit to programs outside DOE-HEP

# **Current** HEP Programs with BNL Involvement

The following HEP programs are currently active at BNL:

- **BNL participation in the CERN LHC Construction Project & Research Program**
  - Host Laboratory and Project Office for the US ATLAS Detector Project
  - ATLAS Detector subsystem leading roles (LAr EM Calorim. and Muon System)
  - Host Laboratory for US ATLAS Computing Project & Tier-1 computing center
  - contributions to LHC physics analysis and accelerator science efforts
  - ATLAS Host Lab for Maintenance & Operations and Upgrade R&D
  - LHC SC dipole prod. at BNL; testing of all LHC SC cable; LHC accel. R&D
- **BNL participation in the MINOS and D0 Programs at Fermilab**
  - major contributors to off-line physics analysis (top, W, SUSY/higgs searches)
  - on-line and off-line computer program upgrades and maintenance
  - operation of the Forward Preshower (FPS) Detector
  - Jon Kotcher is the Run-2 Upgrade project manager for D0 Phase-2
  - Milind Diwan leads the BNL contributions to the MINOS Experiment
- **HEP Experiments using the AGS**
  - E949 [ $K^+ \rightarrow \pi^+ \nu \bar{\nu}$ ] took data in FY02; *FY03 run zeroed out in Pres. Budget*

# **Current** HEP Programs with BNL Involvement

- **BNL in-house research in Experimental and Theoretical Physics**

- 4 HEP analysis efforts using data from HEP experiments at AGS and D0
- 1 HEP design/construction/computing effort for LHC ATLAS
- 2 design/prototyping R&D efforts for planned AGS Exps., KOPIO & MECO\*
- 1 design/constr/physics effort for the MINOS Experiment & Super Neutrino Beams
- HEP Theory is active on topics of current particle physics interest
- a very productive physics interaction with the Riken BNL Research Center
- this program is annually reviewed by DOE and a BSA Visiting Committee

- **Accelerator and Detector R&D Program**

- Accelerator Test Facility (BNL's unique user facility for accelerator science expts.)
- muon collider/storage ring R&D studies (with FNAL, LBNL and university groups)
- superconducting magnet R&D is performed in the SC Magnet Division
- development and testing of novel particle detectors (with BNL Instr. Div.)

\* KOPIO and MECO are experiments in the RSVP Project in NSF's MRE-FC Program; project funding starts in FY06 (FY05?); R&D work is ongoing.

# AGS Complex - Other Program Missions

Other missions and venues in the sponsor-paid 'Work for Others' Program:

<u>Current Work</u>	<u>Sponsor</u>	<u>Expected Future Work</u>
<b>AGS Machine &amp; Staff</b> biological effects of heavy ions proton radiography RSVP R&D runs	NASA NNSA NSF	biological effects of heavy ions dynamic testing/proof-of-principle RSVP experiments
<b>Spallation Neutron Source</b> design/construction of SNS Ring	DOE-BES	commissioning involvement
<b>NASA Space Radiation Laboratory</b> commissioning of the NSRL	NASA	expanded radiobiology studies
<b>Proton Linac BLIP Facility</b> medical isotope production CIRC (BLIP replacement)	DOE NE DOE NE	medical isotope production medical isotope production
<b>Medical Treatment Synchrotron</b> Finish CDR; consolidate consortium	Private	market to other hospital facilities
<b>Tandem Van de Graaff Facility</b> various heavy-ion irradiations	36 Orgs.	continued commercial sales

# Recent HEP Physics Highlights

- **Ray Davis** received the 2002 Nobel Prize in Physics for the BNL Solar Neutrino Experiment
- **Sally Dawson** moved up to Chair-Elect of the DPF Executive Committee in January 2003
- **US ATLAS Detector Proj.** on-budget, on-schedule and responsive; U.S. Host Lab is BNL
- **US ATLAS Computing Proj.** successfully underway but still under-funded in FY03,04
- **LHC Accel. Proj.** at BNL on-budget on-schedule, LHC dipole production & cable testing
- **'RSVP' MRE-FC Project** in R&D phase; construction project starts in FY06 (maybe FY05?)
- **DOE FY 2004 President's Budget** includes a 10 Tflops QCDOC Supercomputer at BNL
- The **AGS Super Neutrino Beam** was presented to the HEPAP Future Facilities Committee in Pittsburgh on February 15, 2003; this is an exciting venue for measuring all the neutrino oscillation parameters in a single experimental venue

# U.S. ATLAS Project Status

- Overall, U.S. ATLAS Detector Project is about 78% complete; the whole project is on-budget and deliverables will meet the CERN schedules
- BNL provides leadership in the LAr, CSC Subprojects & ATLAS Technical Coord; projects are on-budget and will meet the CERN delivery schedules
- The BNL-based Tier-1 Computing Center is operational (**but under-funded**); U.S. ATLAS software efforts pace International ATLAS Computing
- Torre Wenaus now Applications Coordinator in the CERN LHC Grid Comp. Proj, a key CERN mgmt. role that benefits U.S. ATLAS & U.S. CMS
- The U.S. ATLAS *Project Advisory Panel* reviewed plans for the U.S. role in the LHC Research Program for a second time, November 21-22, 2002 and provided recommendations for additional plan improvements
- BNL, as ATLAS Host Laboratory, envisions a Physics Analysis Center at Brookhaven to enhance the physics impact of U.S. collaborators





# Signal Feedthroughs

High density connectors and cables to transfer signals from cold to warm

## U.S. ATLAS is providing:

Overall design, production of 64 Barrel Feedthroughs +spares,  
components for Endcaps feedthroughs, installation, commissioning

Slow controls: temperature, pressure, gas flow

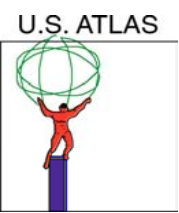
Engineering support

## Project Status:

Installation on the barrel cryostat completed. Pedestals and baseplanes have been installed. The first half of the Barrel EM Modules have been inserted into the cryostat – **an important milestone for ATLAS!**







# U.S. ATLAS Physics Analysis Center

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- **The Tier 1 Computing Center located at BNL will continue to participate in upcoming ATLAS data challenges**
- **BNL has started a Physics Applications Software group which is contributing to the U.S. ATLAS framework and data base effort**
- **BNL has leaders in the Physics, Liquid Argon and Muon software**
- **BNL plans to enlarge the latter two groups, starting in FY04, as well as provide space for visitors for an ATLAS Physics Analysis Center**

# BNL LHC Accelerator Project Status

(Courtesy M. Harrison, LHC Accelerator Project)

- **D1 production & testing complete (5). 1 at CERN, 1 in transit**
- **D2: production complete (9), 4 of 6 tested**
- **D4 collaring complete, 1<sup>st</sup> cold mass assembly started**
- **D3 coils complete, collaring to start shortly**
- **Design effort nearly complete; remaining items:**

D3 top level magnet assembly drawing

- 1 MM design time remains
- 1 MM checking

D1 interconnect to DFBX in design:

- Check print corrections (~0.5 MM)
- 0.5MM checking

- **Design issues since last time:**

CERN-directed D2 cryogenic interface changes (2)

Lack of guidance on D3 interface (still no formal approval)

Aperture spacing change for D4 and D3

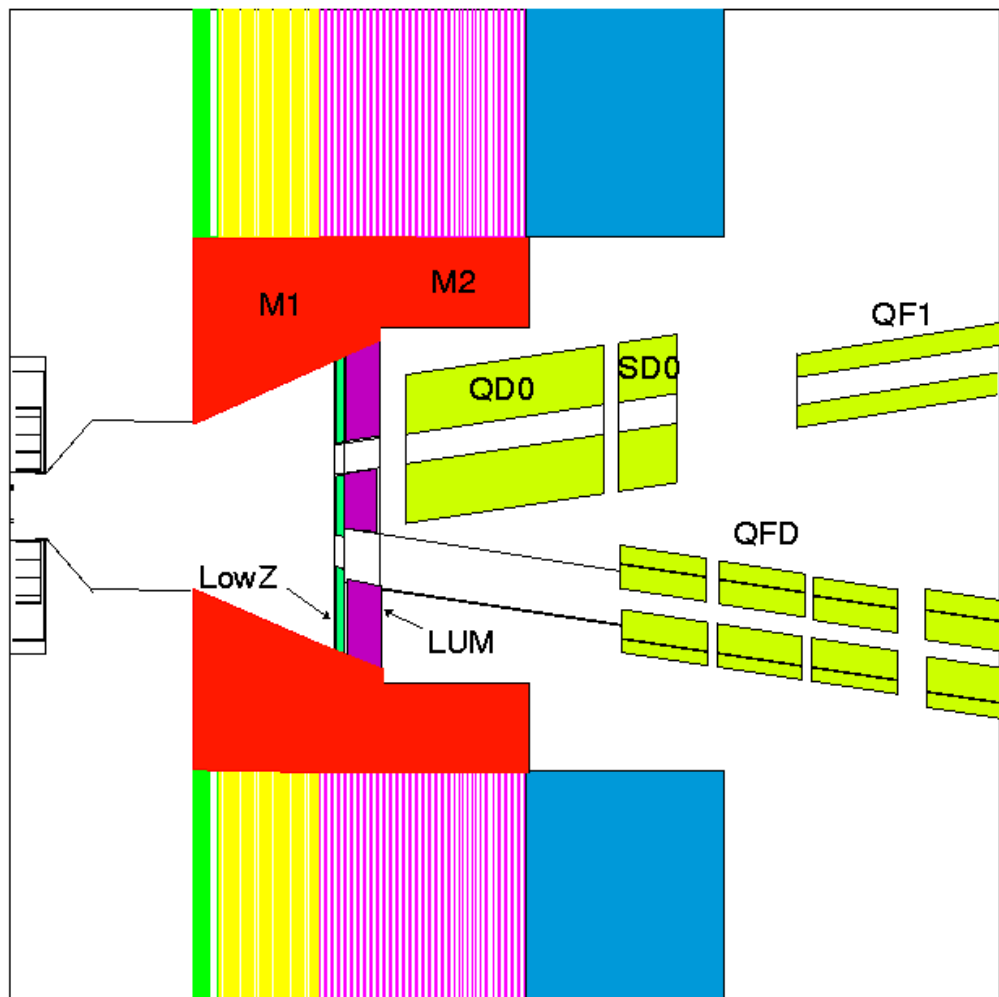
# BNL SC Dipole at CERN - February 2003

## (First Magnet Accepted for LHC Installation)



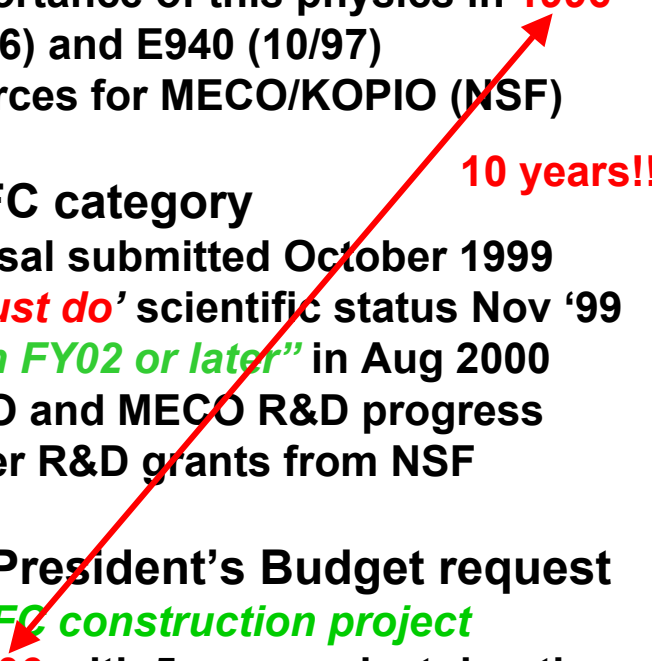
- BNL is providing SC dipole magnets & superconductor cable testing for U.S. LHC Accelerator Constr. Project
- All BNL work is on-budget, on-schedule and meets technical specifications
- The U.S. LHC Accel. Proj. will be complete in FY05
- The U.S. accelerator physicists plan to continue their LHC involvement under the “LHC Accelerator Research Program” which is currently being organized in the U.S. and at CERN

# BNL SMD - Linear Collider Final Focus Concept

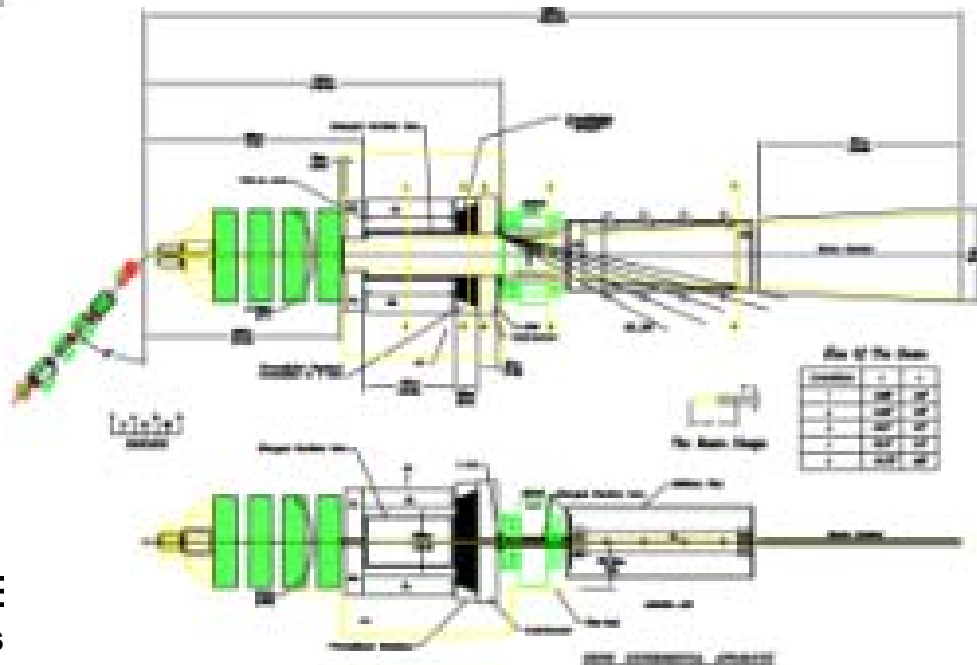


- 20 mrad X-ing angle
- Outgoing beamline used for diagnostics & instrumentation
- 20mm incoming aperture
- Cold option gives flexibility: optics variation, energy variation, improved correction scheme, etc..
- Issues involve mechanical stability (**1nm!**), adjustability, interaction with the solenoid, field stability (5 ppm), and radiation resistance.

# Status of RSVP (MECO + KOPIO)

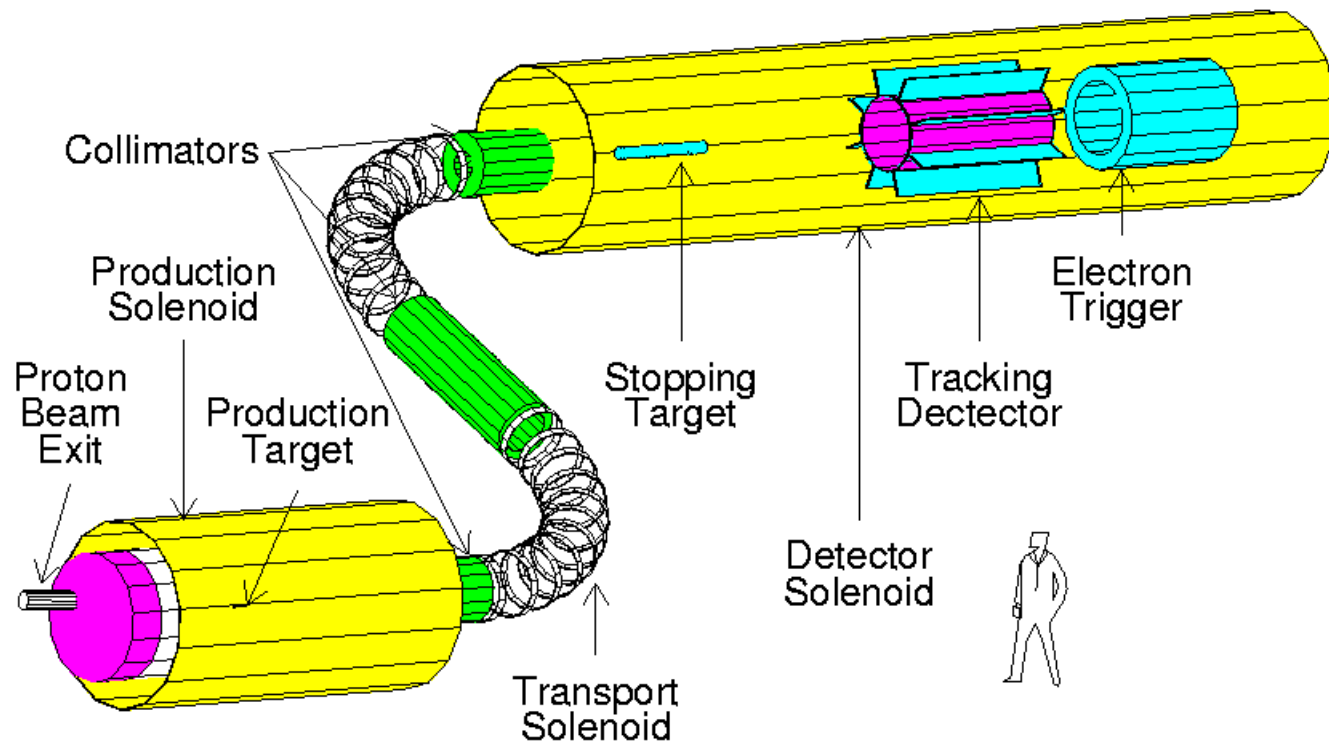
- MECO (muon direct conversion) and KOPIO ( $K^0 \rightarrow \pi^0 \nu \bar{\nu}$ ) approved at BNL
    - PAC invented '**must do**' category to emphasize importance of this physics in **1996**
    - ALD-HENP granted **scientific approval** to E926 (10/96) and E940 (10/97)
    - DOE agreed that BNL could seek other funding sources for MECO/KOPIO (NSF)
  - NSF considered and approved RSVP in the MRE-FC category
    - 'Rare Symmetry Violating Processes' (RSVP) Proposal submitted October 1999
    - **NSF Wojcicki Panel** awarded RSVP experiments '**must do**' scientific status Nov '99
    - **NSF Science Board approved RSVP** **"..for funding in FY02 or later"** in Aug 2000
    - NSF conducts periodic successful reviews of KOPIO and MECO R&D progress
    - KOPIO/MECO advanced their detector designs under R&D grants from NSF
  - NSF submitted RSVP to Congress in the FY 2004 President's Budget request
    - RSVP is accepted by NSF as a **fully approved MRE-FC construction project**
    - the proposed **construction start** was listed as **FY 2006** with 5-year project duration
    - Congress has provided NSF with funding **above** the President's Budget each year
    - RSVP could start in FY 2005 if Congress continues NSF funding increments
    - RSVP collaborations have applied for substantial R&D funding to bridge the gap
    - stay tuned...
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# KOPIO



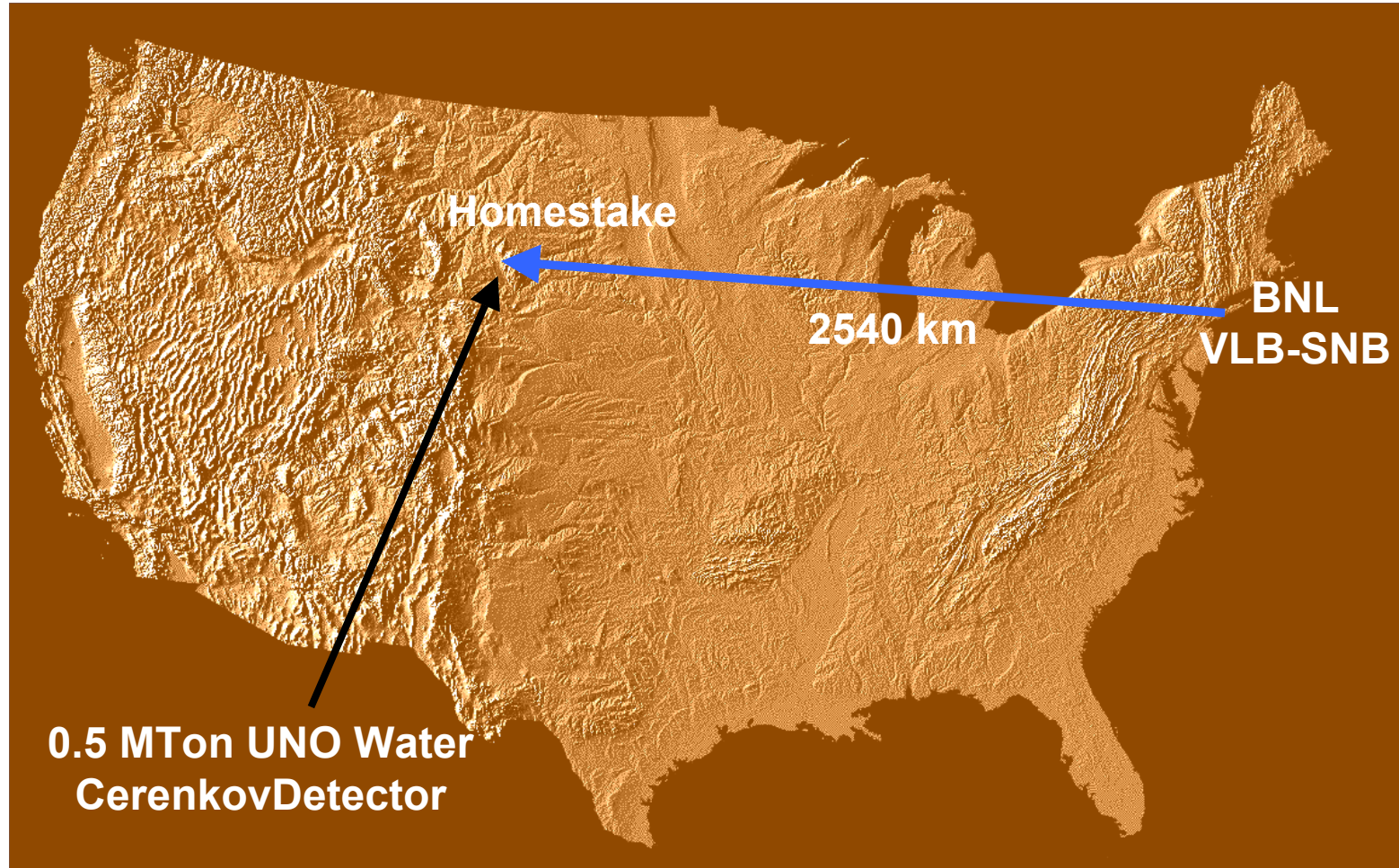
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# MECO Detector



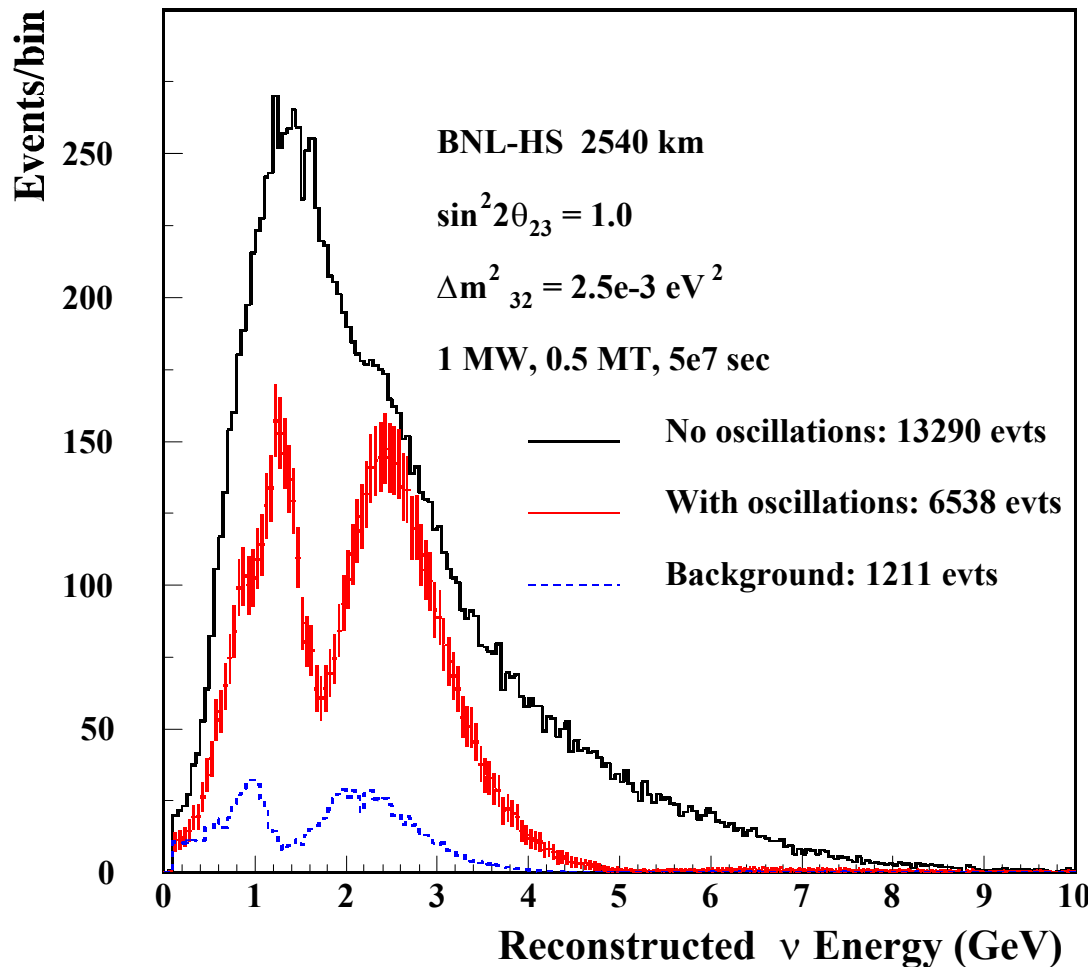


# Potential BNL → Homestake Super Neutrino Beam (Presented to the HEPAP Future Facilities Panel Feb 2003)



# Advantages of a Very Long Baseline

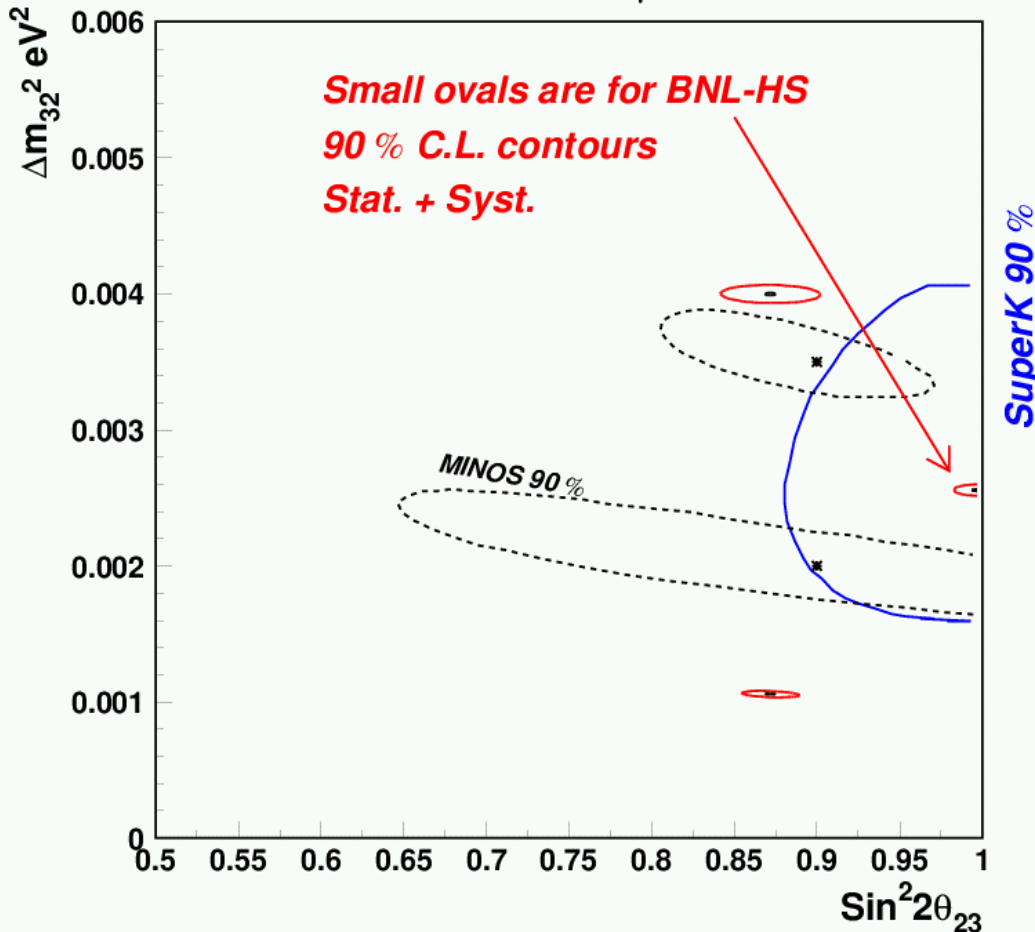
## $\nu_\mu$ DISAPPEARANCE



- neutrino oscillations arise in the factor  $\sin^2(\Delta m_{32}^2 L / 4E)$  modulating the  $\nu$  flux for each flavor (here  $\nu_\mu$  disappearance)
- the oscillation period is proportional to distance and inversely proportional to  $E_\nu$
- a **very long baseline** yields visible oscillations in the data as a function of energy
- the multiple-node structure of the VLB allows the  $\Delta m_{32}^2$  to be measured by a **wavelength** rather than an amplitude (this yields lower systematic errors)

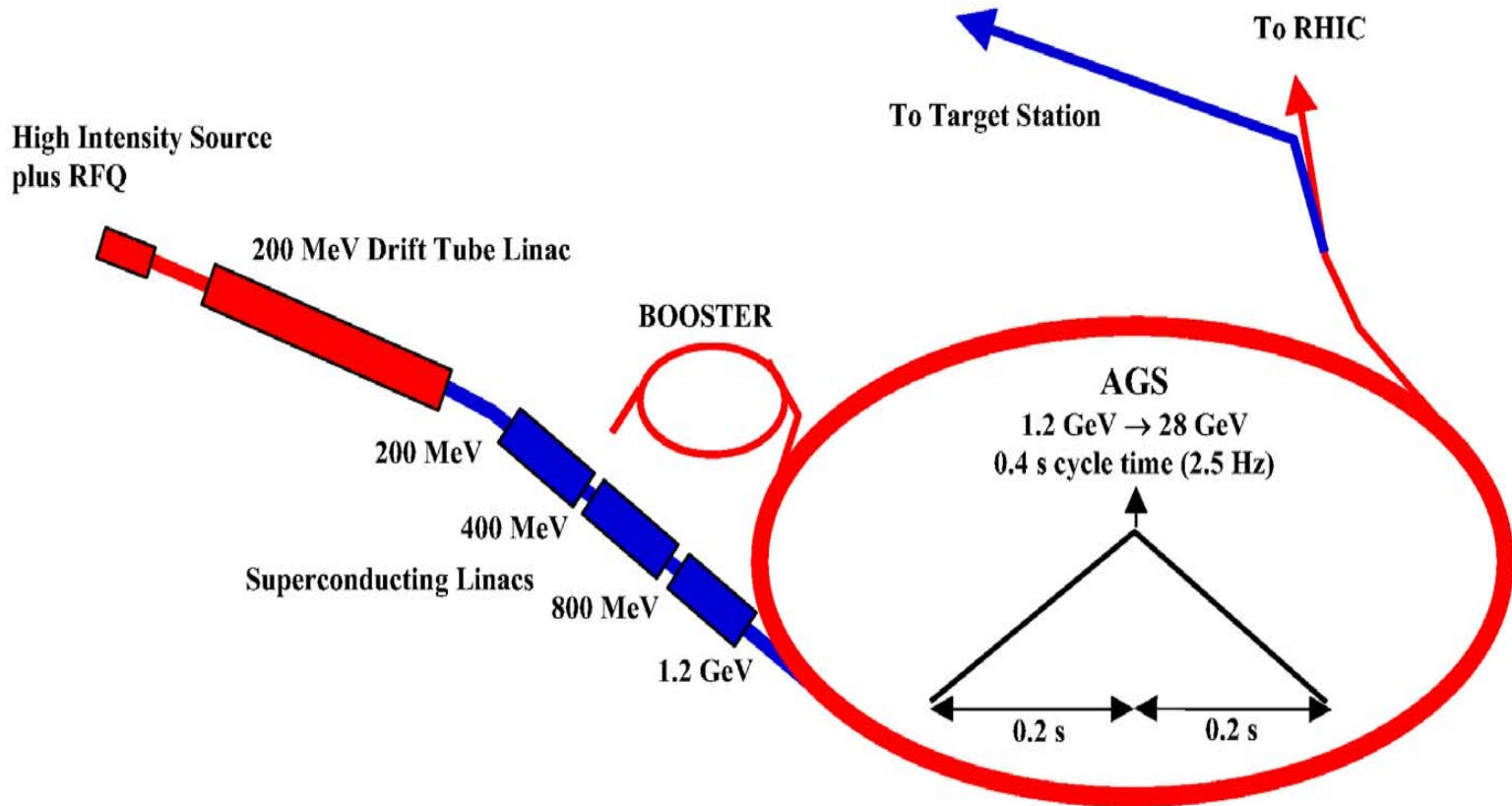
# VLB Application to Measurement of $\Delta m_{32}^2$

Test points for  $\nu_\mu$  disapp



- the multiple node method of VLB measurement is seen by comparing BNL's 5-year measurement precision with present Kamiokande results and projected MINOS 3-year measurement precision; all projected data include both statistical & systematic errors
- no other plan, worldwide, employs the VLB method (a combination of target power and geography limits other potential competitors)
- other planned experiments can't achieve VLB precision

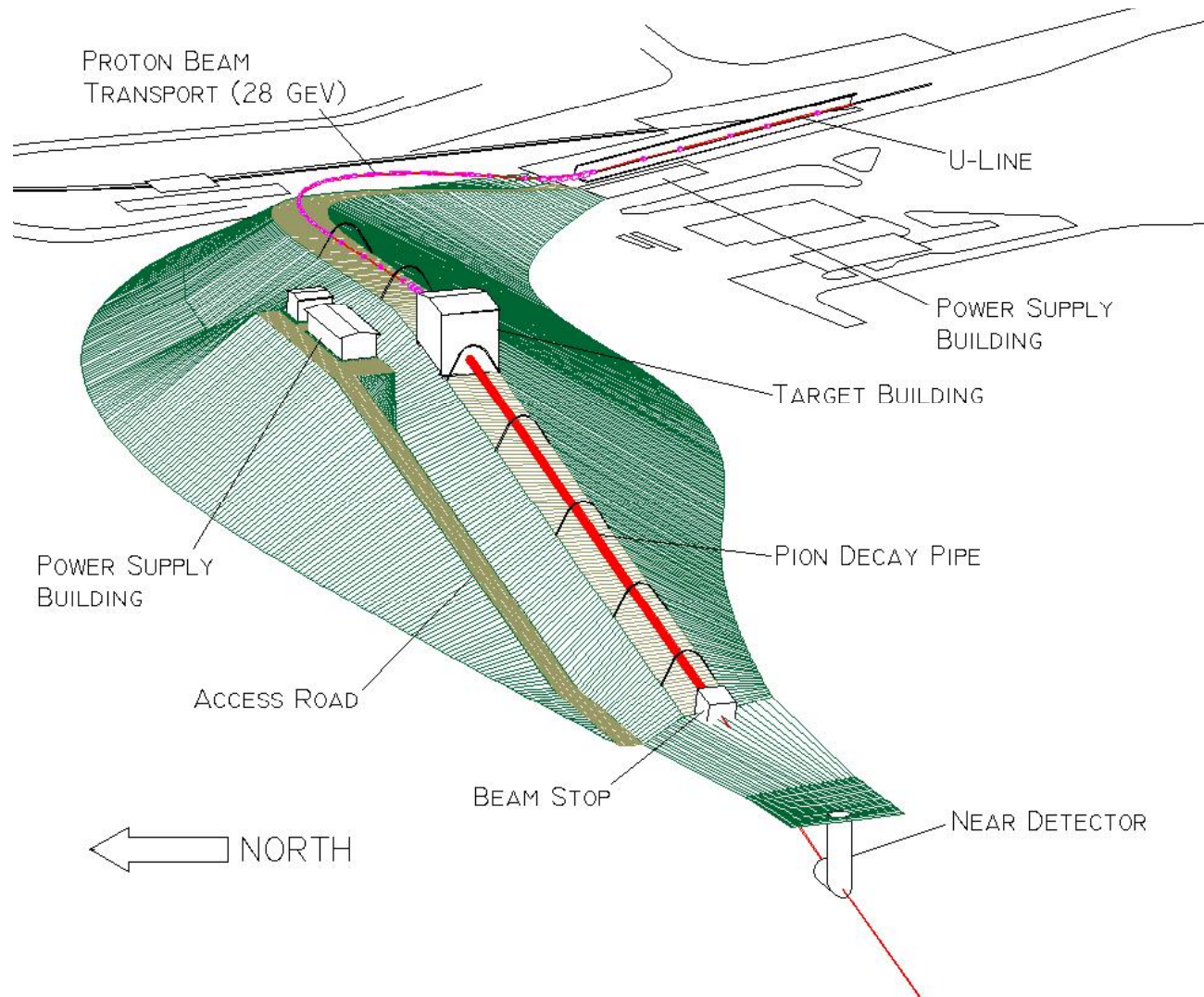
# AGS Target Power Upgrade to 1 MW



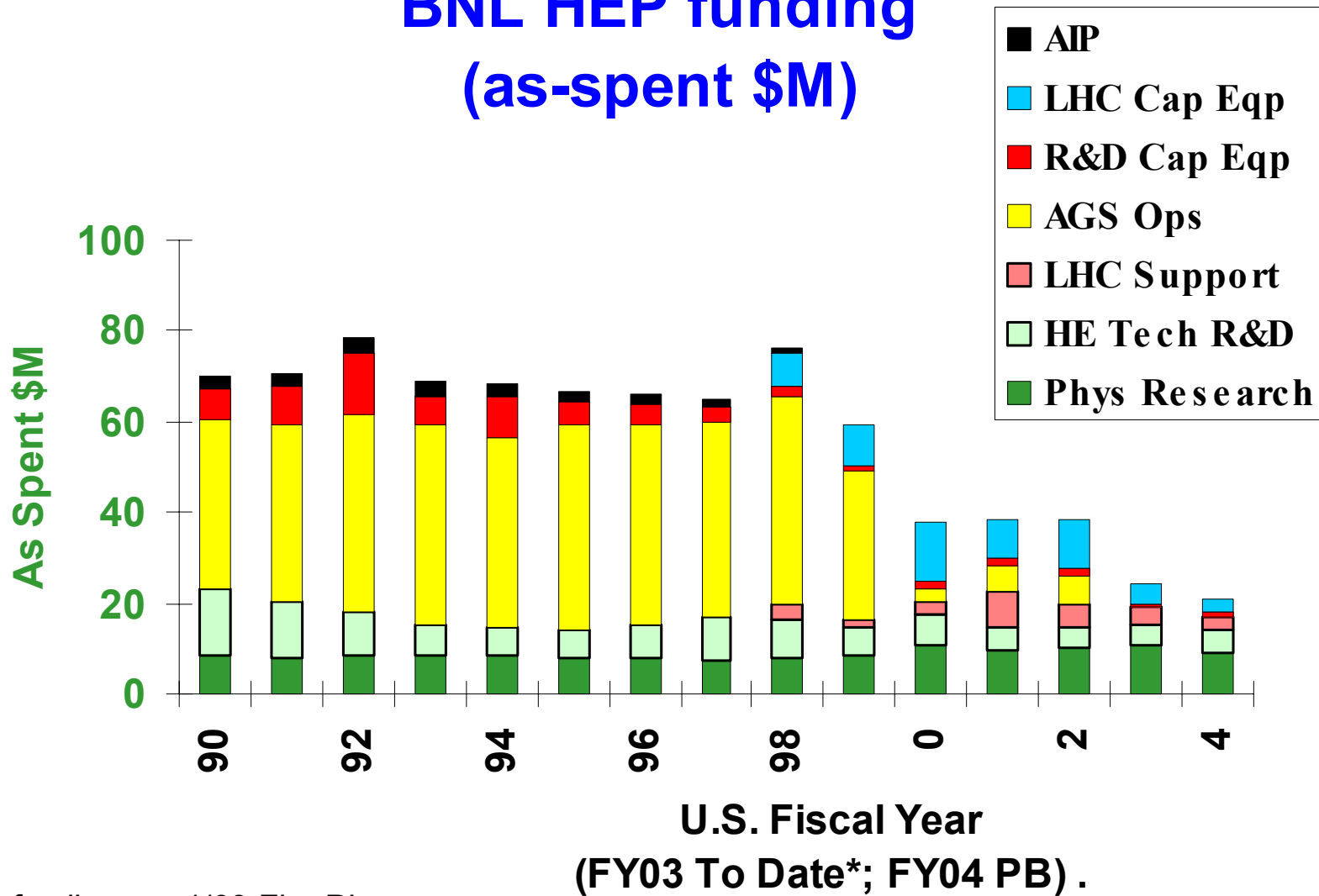
- the **AGS Upgrade** provides protons for a 1.0 MW Super Neutrino Beam; for a total SNB cost of \$369M fully-burdened FY03 dollars (TPC)



# 3-D Neutrino Super Beam Perspective

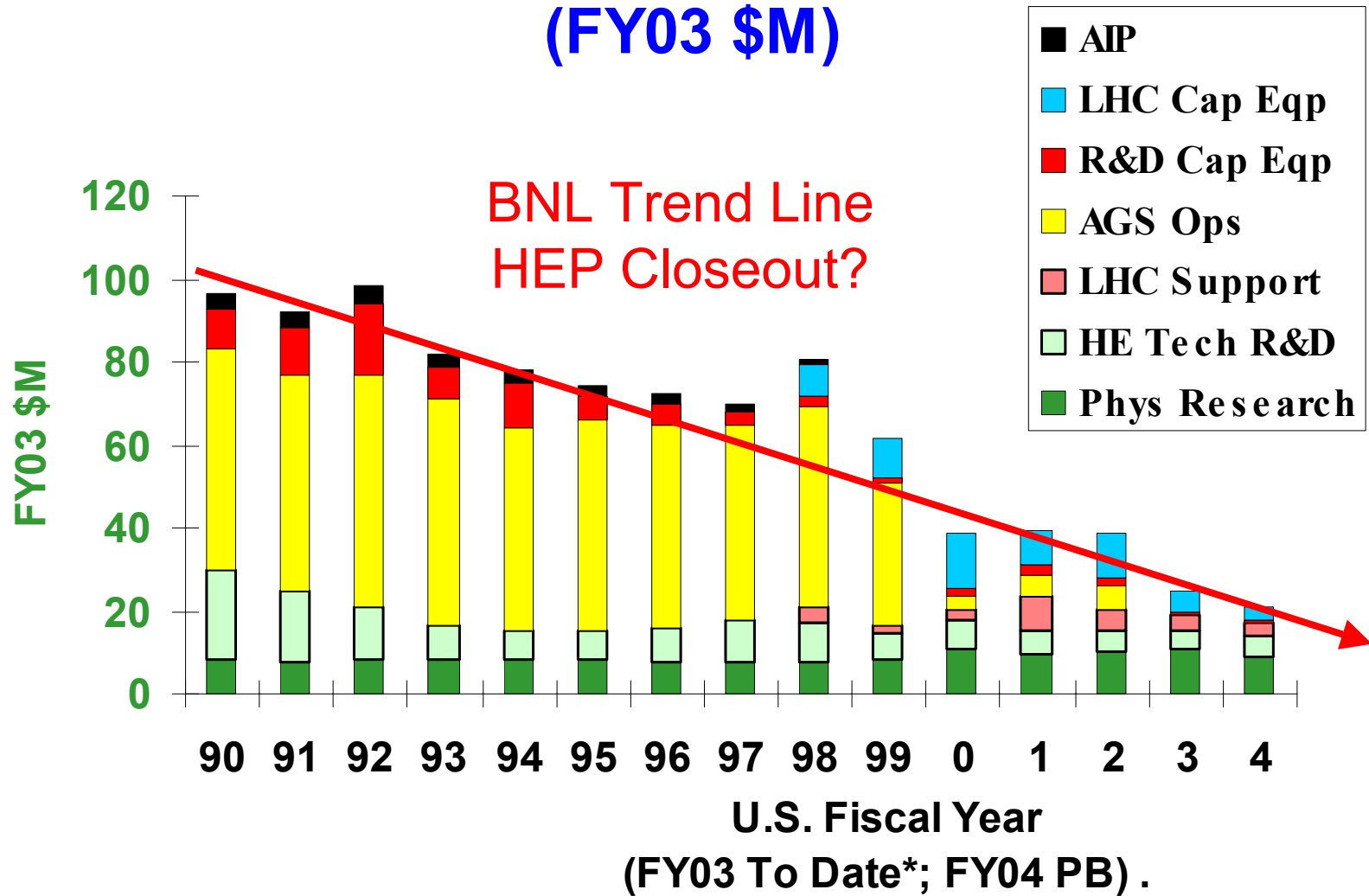


# BNL HEP funding (as-spent \$M)



\* FY03 funding per 1/03 Fin. Plan

# BNL HEP Funding (FY03 \$M)



\* FY03 funding per 1/03 Fin. Plan



# HEP Budgets at BNL & Revised Request by B&R

Budget Category (Ops + Equip)	FY02 Actual (\$M)	FY03 <sup>1</sup> Actual (\$M)	FY04P <sup>2</sup> P. Bud (\$M)	FY04R <sup>3</sup> C. Rev (\$M)
KA 11 01, 02 (Research)				
<b>Phys Research</b>	7.76	8.30 <sup>4</sup>	7.76 <sup>4</sup>	9.16
<b>ATLAS R&amp;D/Constr. Ops.</b>	3.22	2.44	1.30	5.60
<b>LHC Accel. R&amp;D/Constr. Ops.</b>	1.90	1.60	1.90	2.10
<b>AGS Facil. Ops.</b>	6.05	0.00	0.00	8.30
LHC Cap Eqp.	10.83	4.98	2.80	2.80
KA 14 01 01, 03 (Theory)	2.23	2.35	2.43	2.83
KA 15 01, 02 (Accel. R&D)				
Accel. Test Facil. (ATF)	1.68	1.83	2.14	2.24
Genl. Accel, + Det. R&D	1.66	1.82	1.68	2.27
Linear Coll + Muon R&D	1.55	0.95	0.96	3.66
KA 11, 15 (non-LHC Cap Eqp)	1.79	0.30 <sup>4</sup>	0.19 <sup>4</sup>	0.19
<b>Total HEP Funding</b>	38.67	24.57	21.16	39.15
AGS Weeks (SEB/FEB)	10+0	0+0	0+0	25+0

<sup>2</sup> January 2003 DOE Fin. Plan, w/o Waste Mgmt.

<sup>3</sup> BNL Contractor's Revised Request in FY05 Field Work Proposal

<sup>2</sup> FY 2004 President's Budget

<sup>4</sup> Trade-in Equip for Ops funding

# BNL Impacts of FY03,04 Planning Budgets

- BNL scientific staff in the Physics Department will be reduced by **13 FTEs**, in FY03 and **5 FTEs** in FY04 under the current planning budgets; BNL will not be able to fulfill its approved HEP program commitments in these years  
Experimental research efforts that will continue:  
**ATLAS, D0, RSVP, MINOS, E949 analysis**  
Experimental research efforts that will be curtailed:  
**CKM, g-2, EDM, AGS data runs**  
Experimental research efforts that cannot be started:  
**VLB Neutrino and Linear Collider Detector & Physics**
- BNL's plans to advance the ATLAS Computing & Research Program and the LHC Accelerator Research work will be severely impeded under FY03, 04 DOE budget guidance; **this inhibits a U.S. leadership role in ATLAS physics and important contributions to Linear Collider R&D**
- BNL's role in the Muon Collider/Storage Ring R&D program has been cut in half relative to FY01 and seems headed towards zero in future years  
**High-Power Target R&D runs at AGS stopped**  
**Participation in the MICE Collaboration not effective**

# BNL Impacts of FY03 President's Budget (Cont.)

- AGS will not run in FY03 or FY04:
  - E949 will not make the planned advance in the measurement of  $K^+ \rightarrow \pi^+ \nu \bar{\nu}$ , as approved by DOE in August 1999
  - E962, Muon (g-2), will not be able to reduce the statistical error to the level of the systematic error

*these are losses at the frontier of particle physics!*
- BNL's proposal to contribute value to the Linear Collider with Final Focus quadrupole design and spatial stabilization R&D is not supported in FY04

# What Can HEPAP Do?

(reiterated from last year)

- Articulate the value of a strong and diverse HEP research program as a vital part of the U.S. basic research portfolio  
(we need to broaden our base on the experimental side with opportunities identified in the Subpanel's Long Range Planning Report)
- Engage the other national advisory committees to forward the agenda of the physical sciences in the national basic research program